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AUTHOR

David J. Jendrzejczyk, C.P. is with Newington Children's Hospital, 181 East Cedar Street, Newington, Connecticut 06111.

Technical Article

Flex-Frame Sockets in Upper Extremity Prosthetics

by Donald L. Fornuff, C.P.

The development of various new plastic materials has brought about a rapid change in the design and fabrication of lower extremity prosthetic sockets. We can now expect most of these revolutionary developments to overflow into other areas of prosthetics and orthotics. The most natural area next to be influenced is upper limb prosthetics.

We at Rusk Institute of Rehabilitation Medicine have been trying various socket frame configurations with all levels of upper limb amputees, from wrist disarticulations to above elbows, including the humeral neck amputation.

The following is a brief "technical note" describing the technique we use for fabricating the flex-frame socket for the upper limb prosthesis and a sampling of various socket designs.

BELOW ELBOW SOCKET

When the below elbow socket model has been modified and smoothed, a flexible socket is made by vacuum molding, using Surlyn or Ethalux polypropylene (Figure 1). A thin socket is then laminated in the conventional fashion over the flexible socket (Figure 2). This socket will act as a frame for the flexible socket and will allow for the secure attachment of the forearm extension and wrist unit. Upon completion of the thin laminated socket, the P.V.A.

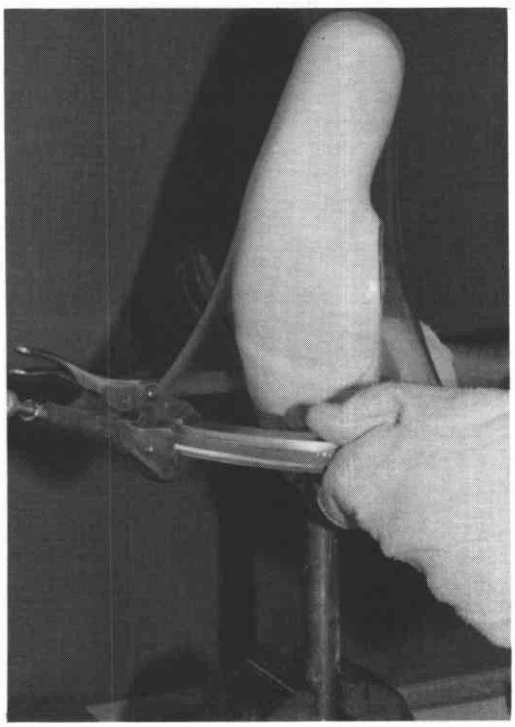

Figure 1. A flexible socket is made by vacuum molding, using Surlyn(R) or Ethalux polypropylene.

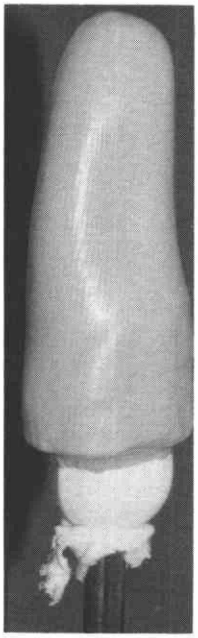

Figure 2.

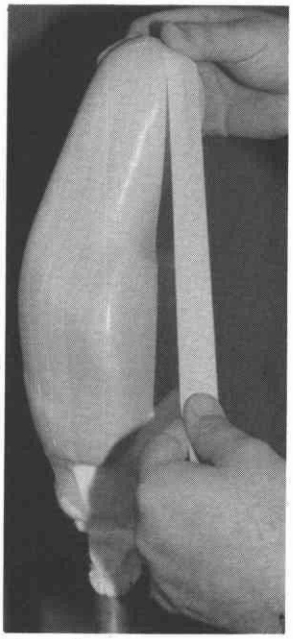

Figure 3.

Figure 4.

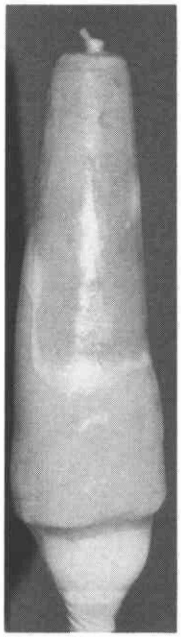

Figure 5.

sleeve is removed. The socket is then covered, using strips of 1″ masking tape (Figure 3).

The forearm extension form, or mold, holding the wrist unit is mounted to the below elbow socket in the correct alignment, position, and length (Figure 4). The wrist unit is taped over to prevent foam from clogging various screw holes. A hole is cut in the forearm extension piece just proximal to the wrist unit. Foam is poured into this hole to form the forearm extension piece. Additional foam may be required to ensure proper shaping of the forearm section. When shaping is completed, the wrist unit is heated slightly and removed. Vaseline® is applied to the remaining foam and socket, and a P.V.A. sleeve is pulled on and tied at both ends (Figure 5). The wrist unit is replaced over the P.V.A. sleeve, held in place by the layers of material to be used in the second lamination. The material is tied off in the usual manner.

When the forearm has been laminated, it should be completely removed from the below elbow socket and foam extension (Figure 6). This removal is relatively easy because of the P.V.A. sleeve applied over the shaped foam forearm section. After the laminated forearm is removed, the foamed forearm section and tape are completely removed from the laminated socket.

The laminated and vacuum molded flexible sockets are removed from the model (the model

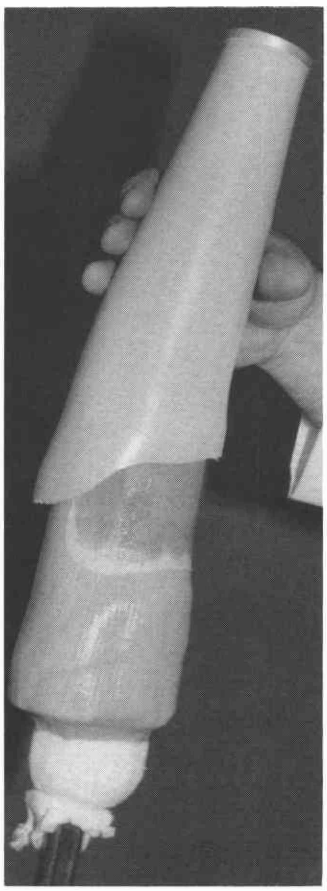

Figure 6.

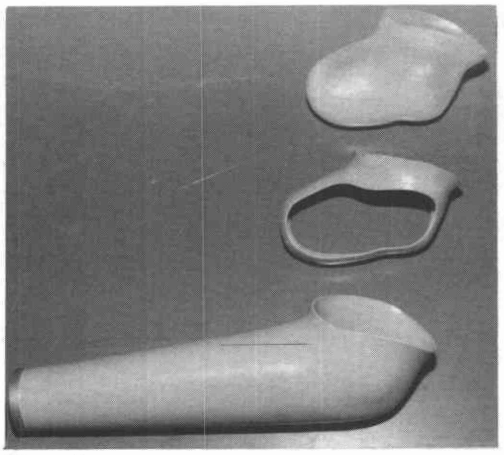

Figure 7.

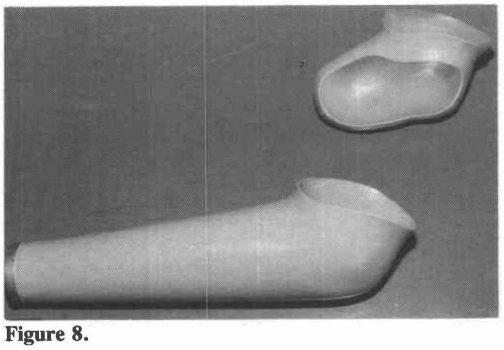

Figure 8.

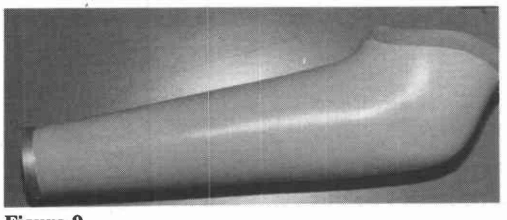

Figure 9.

must be broken many times) and the laminated socket frame is cut to its desired shape to allow maximum flexibility of the flexible socket (Figures 7 and 8).

The frame socket is placed into the forearm section and trim lines are established. Both sections are then sealed together. The flexible socket is placed in the frame socket and the trim line is established: 1/8" to 1/4" above the edge of the laminated frame socket to minimize the stiffness gradient and to allow a gradual transition from the flexible socket to the rigid frame (Figure 9). Socket designs are many and quite variable (Figures 10 and 11).

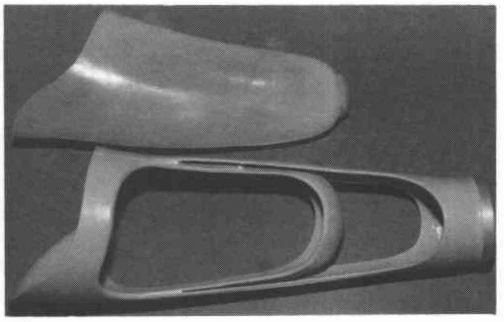

Figure 10.

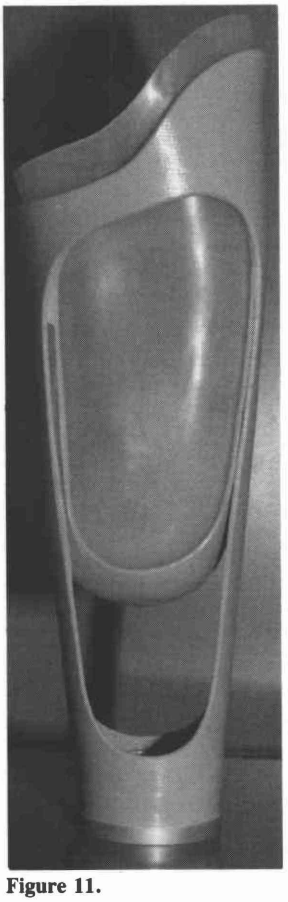

Figure 11.

ABOVE ELBOW SOCKET

All previous steps used in the below elbow prosthesis apply to the above elbow prosthesis until removal of the laminated humeral section with the attached elbow turntable. When the humeral section is removed from the foamed humeral extension, it is set aside (Figure 12), while the laminated above elbow socket is cut out to allow maximum flexibility of the flexible socket. The laminated humeral extension holding the turntable is then re-attached to the

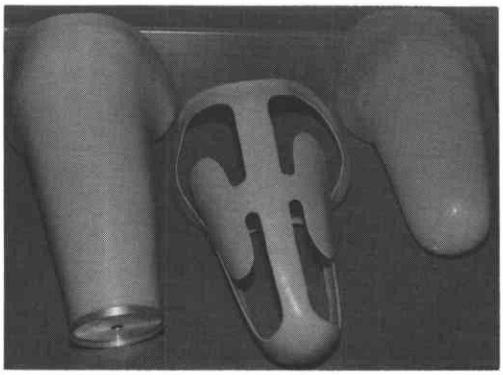

Figure 12.

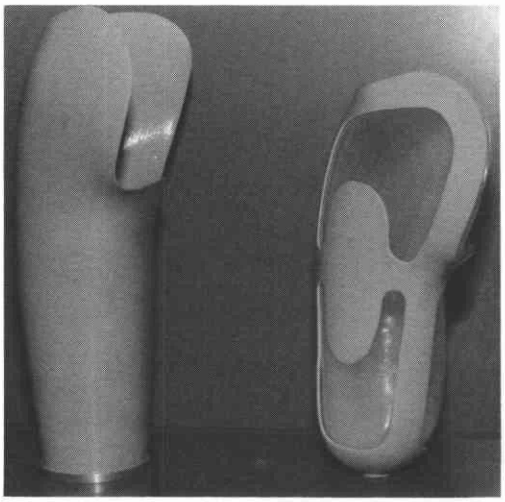

Figure 13.

flex-frame socket with a rigid plastic resin (Figure 13). Easy removal of the flexible socket will allow for easy access to the elbow friction and attachment nut at the elbow turntable.

Again, configurations of both below and above elbow flex-frame sockets are many in design, but must provide attachment areas for harnessing and base plates for proper transition of the cable control system.

AUTHOR

Donald L. Fornuff, C.P., was formerly Assistant Director of Orthotics and Prosthetics at Rusk Institute of Rehabilitation Medicine, New York, New York.

He is presently Director of Medishare Orthotics and Prosthetics Laboratories, Fords, New Jersey.

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